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ABSTRACT

The goal of this research was to find conveniently administered measures which could provide objective data concerning problem solving skills of applicants to medical schools. The instruments were to be free of medical content so they could be administered to any medical school applicant. However, personal qualities relevant to the demands of medical practice were also to be measured, so that performance in clinical settings could be predicted. The sample consisted of 54 paid volunteers, representative of third and fourth year medical students. Six tests were selected as predictor variables in a set of regression equations. Measures of the dependent variable, skills in problem solving, included peer and faculty ratings, in addition to four measures which indirectly assessed problem solving: number of courses deferred in the first two years of medical school, number of clerkships deferred in the clinical years, scores on a multiple choice test, and a score derived from a series of diagnostic management problems. These measures were analyzed by multiple regression analysis. Results showed that predictions of student performance in clinical clerkships can be improved by using easily administered tests to supplement Medical College Admissions Test scores and grade point average.
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ASSESSMENT OF PROBLEM-SOLVING SKILLS AS A SCREEN FOR MEDICAL SCHOOL ADMISSIONS

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Statement of Problem

None of the traditional techniques for selecting medical students is perfect. Measures of academic quality, such as Medical College Admissions Test (MCAT) scores and grade point averages (GPA), predict grades in the pre-clinical years fairly well but do not predict clinical performance nearly as well (Howell and Vincent, 1967; Rhoads et al., 1974; Wingard and Williamson, 1973). There is reason to believe that measures of certain personal qualities are correlated with performance ratings in the clinical portion of medical education as much as or perhaps more than measures of academic achievement. In particular, since the range of academic achievement among medical students is restricted by the selection process itself, variation in personal qualities may be all that remains to account for variability in clinical performance. The most widely used measures of personal qualities are probably letters of recommendation and interviews of applicants. However, letters of reference do not discriminate well among applicants (Elstein and Teitelbaum, 1975) and interviews are too costly to be used with every applicant.

An important ethical problem arises, too, since many measures of personal qualities require that the subject reveal inadequacies, deficiencies, or concerns. In a selection process very clearly oriented toward selecting the "best," this demand places the applicant in a situation where honesty may not be the best policy. In addition, such tests are frequently subtle or even deceptive; the unwary applicant may unwittingly reveal qualities without having been informed that those qualities were even likely to be measured.

Therefore, the goal of this research was to find or to develop a set of conveniently administered measures which could provide objective data concerning some relevant personal qualities of all applicants. The instruments were to be sufficiently free of medical content that they could be administered to any college student seeking entry to medical school, yet measure personal qualities sufficiently relevant to the demands of medical practice that performance in clinical settings could be predicted. The educational philosophy of Michigan State University's College of Human Medicine (CHM) as well as broader trends in medical education indicated that one of the personal qualities which merited attention was skill in problem solving. Our research strategy was to select existing tests which had potential for measuring this quality.

Ideally new predictors should be validated against the ultimate criterion of long-term performance on the job (Thorndike, 1949). For physicians, however, this ultimate criterion is rarely obtainable and therefore intermediate criteria such as clinical performance in medical school must be used. The experimental instruments were thus validated against peer and faculty ratings of student performance in clinical clerkships.

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As Cronbach and Gleser (1965) noted, the usefulness of a test is not solely a function of its validity. A test is useful to the extent that it explains and allows us to predict variance not already explained by existing predictors. The question is not, are the new tests related to measures of clinical performance? Rather, the proper question is: how much gain in predictive power is afforded by the new measures, given the variance accounted for by traditional measures? Medical school admissions committees have traditionally used GPA and MCAT to estimate potential for success in medical school. We assumed that these measures would continue to be widely employed and that any new measures would have to account for additional variance. The following hypothesis regarding problem solving skills was therefore formulated:

> The variance of problem-solving criteria accounted for by a linear combination of measures of problem-solving skills, grade point average, and MCAT scores will, after shrinkage, exceed the variance of the same criteria accounted for by a linear combination of MCAT scores and GPA.

Method

Subjects

The sample consisted of third and fourth year students in the College of Human Medicine at Michigan State University in the spring of 1977. The students were on clerkships in one of five community campuses. The fifty-four students who participated in the study were paid volunteers and were not drawn as a ramdom sample of the 182 third and fourth year students in the college at that time. The subjects, however, appeared to be reasonably representative of the third and fourth year classes in terms of mean MCAT scores and GPA. The only important difference was that significantly fewer minority students were in the research sample ($\chi^2 = 3.88$, $df = 1$, $p < .05$).

Tests of Problem Solving

After a comprehensive review of the literature on problem solving and personality correlates of problem solving, discussions were conducted with members of the medical faculty of the school to determine what aspects of clinical performance should be included under the concept of problem solving. The inquiry model of clinical reasoning (Elstein, Shulman and Sprafka, 1978) seemed to provide a reasonable first formulation for the definition of medical problem solving. This theory of clinical reasoning directs attention to hypothesis generation as a significant component of the diagnostic process. This is the operation whereby hypothetical solutions to medical problems are generated based on a limited number of cues. The importance of this operation in clinical reasoning suggested that tests of associative fluency, verbal productivity, flexibility, ability to draw inferences from data, and skill in reasoning from parts to wholes might well be related to ratings of clinical performance. We were also interested in the effects of anxiety upon ratings of clinical performance.

As a result of the literature review and discussions, the following tests were selected as measures of aspects of problem solving and as predictor variables in a set of regression equations:

1. SRA Pictorial Reasoning Test (McMurry and Arnold, 1973), a test of general ability developed empirically to minimize differences across major American cultural subgroups;

2. Remote Associates Test (Mednick and Mednick, 1967), designed to measure individual differences in an ability considered by its authors to be fundamental to the creative thinking process;

3. Watson-Glaser Critical Thinking Appraisal (Watson and Glaser, 1964), a series of exercises requiring the application of some of the important abilities involved in critical thinking;

4. State-Trait Anxiety Inventory (Spielberger et al., 1970), composed of separate self-report scales for measuring two anxiety constructs, state anxiety (A-state) and trait anxiety (A-trait);

5. IPAT Anxiety Scale (Krug et al., 1976), a checklist for obtaining clinical information about anxiety level in a rapid, objective, and standard manner; and

6. The Study-Habits Inventory (Wrenn, 1941), a weighted checklist of specific study habits and attitudes which high-scholarship and low-scholarship groups of students have been found to possess in differing proportions.

Dependent Variables

Several measures of the dependent variable, skill in problem solving, were used. Peer ratings and faculty ratings of problem solving skill were obtained, and problem solving was also assessed indirectly by four measures: number of courses deferred in the first two years of medical school, number of clerkships deferred in the clinical years, scores on a multiple-choice test, and a score derived from a series of diagnostic management problems administered in the pediatrics clerkship. These measures will now be described in some detail.

Peer Problem-Solving Rating - The third and fourth year students were asked to provide ratings of medical problem solving ability for their peers in various clerkships. For purposes of this rating, medical problem-solving was defined as the ability to integrate physical findings, to focus the search for information on coherent and relevant problem formulations, to interpret data accurately, and to use findings and conclusions to organize a rational plan of treatment for the patient. Students were provided with a list of other students currently in the community where they were serving their clerkships and asked to rate each on a seven-point scale from weak to strong. The rating for each student was the mean of all ratings provided on that individual.

Faculty Problem-Solving Rating - A summary of the student's performance in the pediatrics clerkship, based on averaged faculty assessments of the student's data-gathering skills and medical knowledge. Direct observation of clinical skills and interpretation of test scores were employed by the faculty in making these judgments.

Multiple-Choice Test Score - Multiple-choice tests were administered to each student at the end of six-week clerkships in both medicine and pediatrics. Each test was composed of 75 items. Scores on these two tests were averaged to develop this dependent variable.

Clinical Problem Score - This score was developed from the students' scores on a number of diagnostic management problems. These problems are scored for overall process, diagnostic accuracy, efficiency, errors of omission, and errors of commission. Correlations between the scores were factors analyzed and the factor loadings were used to develop a formula for combining the separate scores

into an overall clinical problem score. The formula is:

Clinical Problem Score = (Process + Efficiency + Diagnostic Accuracy - Errors of Omission) /4.

Courses Deferred - This variable refers to the total number of clerkships that the student deferred in the last two years of medical school. Since the fourth year students had more opportunity to defer clerkships than the third year students, the number of clerkships deferred was standardized.

Results

Our purpose was to find inexpensive, conveniently administered measures that predicted an aspect of clinical performance in third and fourth year clerkships not well predicted by techniques currently in use. The increment in prediction was assessed by a formula for the difference between variance accounted for by the experimental tests and variance accounted for by MCAT and GPA.

The method of analysis used with these measures was step-wise multiple regression analysis. The dependent measures of problem-solving skills were predicted by the experimental problem-solving tests, with MCAT scores and GPA stepped-in first. Regression equations were developed and the results of these analyses are presented in Table 1. (The MCAT scores available on these students were from the old test, but a brief comparative analysis indicated that the general outline of the findings would apply to the new test as well.)

TABLE 1

Regression Analysis of Problem-Solving Variables

Problem-Solving Dependent Variables	n	R	R^2 TOTAL	R^2 MCAT, GPA	Gain	Estimated R^2 after shrinkage	Estimated Gain Using Shrunken R
Peer Problem Solving Rating	30	.564	.319	.034	28.5%	.03	-.4%
Faculty Problem Solving Rating	21	.637	.406	.011	39.5%	.09	7.9%
Multiple Choice Test Score	21	.718	.516	.180	33.6%	.30	11.9%
Clinical Problem Solving Score	21	.681	.464	.035	42.9%	.19	15.5%
Number of Courses Deferred	29	.571	.282	.017	26.5%	.09	7.3%
Number of Clerkships Deferred	29	.545	.298	.151	14.7%	.07	-8.1%

The gain scores show impressive increases in predictive accuracy for four of the six variables. Peer problem-solving ratings and clerkships deferred are not well estimated (after shrinkage) by the experimental predictors, but neither are they well estimated by GPA and MCAT. Since we were successful in predicting the other four criteria of clinical performance and since peer problem-solving ratings and clerkships deferred were essentially uncorrelated with the other criteria, this failure to predict may mean that peer ratings and clerkships deferred are relatively poor measures of medical school performance.

For the other equations, the increase in predictive gain (after shrinkage) ranges from 7.3% to 15.5% with an average increase of 10.7%. Thus, even with a small, highly selected sample, rather global measures of clinical performance, and a very conservative estimate of gain, impressive gains in predictive efficiency were noted for four of the six criteria.

Unique regression weights cannot be estimated for these equations because the sample sizes were too small. However, some interesting patterns of predictor usage were noted in the regression equations for the four criteria estimated best. The measures of state anxiety entered into the equation predicting multiple-choice test performance in the clerkships, while trait anxiety measures entered into the equations predicting faculty ratings, peer ratings, and courses deferred. Thus, the measure of situational anxiety (state anxiety) is more predictive of a situational criterion (test scores), while the long-term measures of anxiety are more predictive of criteria based on long-term performance (i.e., ratings and courses deferred).

The Study Habits Inventory contributed to prediction of all criterion variables except courses deferred. Good study habits are probably indicative of being organized, punctual and conscientious, and thus can affect problem-solving scores and multiple-choice test scores (where organization is quite important). Faculty and peer ratings of problem solving may also be affected by the personal habits and appearance of the student being rated. The number of clerkships deferred, however, is unaffected by these qualities.

In addition to the anxiety measures and the Study Habits Inventory, each cognitive predictor (Critical Thinking Appraisal, Remote Associates, and SRA Pictorial Reasoning) appeared at least once in the regression equations. A clear pattern did not emerge, but conceptual fluidity (measured by the Remote Associates Test) seems less important than we had thought and critical analytic skill seems recurrently relevant.

Anxiety scales, which normally fall within the domain of personality measurement, seem to predict medical school performance as well as or better than measures of cognitive ability. Since the subjects were already highly selected on cognitive predictors such as GPA and MCAT scores, this finding suggests that accomplishments in medical school are a function of intellectual ability plus other traits, both cognitive and emotional, that are not well assessed by traditional cognitive measures. Our data tend to indicate that personality traits as well as cognitive abilities are important aspects of the set of abilities needed to succeed in medical school.

Discussion

It is unfortunate that the size of our sample was so small, especially compared to the group of potential subjects - approximately 200 third and fourth year medical students. We had hoped that both financial incentives and the opportunity to participate in research on an important issue in medical education would prompt broader student participation. In any event, participation was clearly voluntary; every means we could devise to enlarge the sample was employed.

The study has two problems which characterize nearly all studies of prediction of job performance--small samples are available and it is difficult to

obtain ratings from judges that are not dominated by a single global impression. Distinct traits are not well rated. In addition, the restricted variability of faculty ratings raises substantial psychometric problems. Given all of these constraints--small samples that are already highly selected with respect to certain abilities, problems in obtaining good criterion measures, and restriction of range on the dependent variables--we believe that the gains reported in predicting ratings of clinical performance are significant and merit the attention of both medical school admissions officers and researchers in the field of medical student selection.

We have shown that predictions of ratings of student performance in clinical clerkships in medical school can be improved by using a few easily administered tests to supplement MCAT scores and GPA. The improvement is modest, to be sure, but worthwhile. A brief comparative analysis of the old and new MCAT examination indicated that the contribution of the experimental tests was not preempted by the new MCAT. Further work will refine these measures and the weights given to scores on each.

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